Little Blue River Basin

The Little Blue River in Nebraska is located in south-central Nebraska and flows into Kansas where it becomes a tributary of the Big Blue River, Figure LB-1. The major tributary to the Little Blue River in Nebraska is Big Sandy Creek, Figure LB-2. The total area of the Little Blue River Basin (Basin) in Nebraska is approximately 2,500 square miles and includes all of Thayer County and portions of Adams, Clay, Fillmore, Franklin, Jefferson, Kearney, Nuckolls, Saline, and Webster counties. County seats in the Basin include Clay Center, Fairbury, Hastings, Hebron, Minden, and Nelson.

Sources of Water

Precipitation

Annual and growing season (May 1 through September 30) precipitation charts for gage sites in Clay Center, Fairbury, Hastings, Hebron, and Nelson are shown on Figures LB-3 through LB-12. The average annual precipitation ranges from 24.9 inches at Minden in the northwest corner of the Basin to 30.5 inches at Fairbury in the southeast corner of the Basin. The average growing season precipitation ranges from 17.2 inches at Minden to 20.3 inches at Fairbury. Locations of the precipitation gages can be seen in Figure LB-13.

Ground Water

The hydrogeology of the Basin is complex due to its glacial origin (in the extreme eastern end) and the influence of recent (Pleistocene) sediments. The extreme eastern part of the Basin has been glaciated, Figure LB-14 (CSD 2005). For purposes of this report, all saturated unconsolidated sediments of Quaternary age above bedrock inclusive of the paleovalley alluvial aquifers and those small areas of bedrock Tertiary Ogallala Group were combined into the principal aquifer unit for the Basin. Secondary aquifers are made up of the remaining bedrock aquifers. Tables LB-1 and LB-2 list the aquifers by age with the important hydrogeologic characteristics. The bedrock aquifers range in age from Tertiary to Permian, Figure LB-15. The bedrock aquifers supply a small amount of water compared to the other aquifers, but are an important source locally (CSD, 2005). The bedrock aquifers generally are not in hydrologic connection with the streams in the Basin.

The principal aquifer varies in saturated thickness from 0 to approximately 400 feet, Figure LB-16. Depth to water from the land surface varies from 0 to more than 200 feet, Figure LB-17 (CSD 2005). Transmissivity values range from less than 20,000 gallons per day per foot (gal/day/ft) to more than 300,000 gal/day/ft. Most areas of the Basin have high transmissivity values, exceeding 50,000 gal/day/ft where mapped, Figure LB-18. Areas of higher transmissivity are generally related to the Pleistocene age aquifers. Specific yield ranges from less than 5 to greater than 25 percent, Figure LB-19. The principal aquifer is generally unconfined and in hydrologic connection with the streams (CSD 2005). The ground water table, Figure LB-20, reflects the regional nature of the ground water table in the western end, the gaining nature of the streams in the central portion, and the complexity of the glaciated area at the eastern edge of the Basin. Ground water tends to move from the uplands to the streams; however, the ground water contour map should not be taken as an expression of hydrologic connection (CSD 2005).

Ground Water Use

Ground water in the Basin is used for a variety of purposes: domestic, industrial, livestock, irrigation, and others. There are 7,852 registered ground water wells within the Basin as of October 1, 2005 (Department registered ground water wells database). Not all wells are registered in the Department database, especially stock and domestic wells, which if drilled prior to 1993 are not required to be registered. Certain dewatering and other temporary wells are not required to be registered. Irrigation is the largest consumer of ground water, with approximately 850,000 acres being supplied with water from approximately 7,000 wells as of October 1, 2005 (Department registered ground water wells database).

Ground water development is limited within the Basin by the geology of the area. Figure LB-21 illustrates the location of depletive ground water wells. The areal extent of those wells indicates where ground water has been beneficially developed. In the east end of the Basin, wells are mostly found in the paleovalleys and alluvial aquifers. The western and central sections of the Basin show the broad extent of the principal aquifer and irrigation suitability of the overlying lands. The western part of the Basin lies over the principal aquifer, but development is limited to only those lands suitable to irrigation. Ground water development analyzed by comparison of completion dates has shown that development of high capacity wells (depletive wells capable of pumping more than 50 gallons per minute) has been steadily increasing with accelerated increases during the years 1967 through 1983 and 1994 to the present, Figures, LB-22, LB-23, and LB-24. Table LB-3 shows the estimated average irrigated acreage by county within the Basin between 1950 and 2003. The increase in the number of other depletive wells seen in Figures LB-23 and LB-24 after 1993 is attributed to revision of the well registration statute in 1993.

Changes in Ground Water Table Elevation

Figure LB-25 is a map made from a compilation of all ground water elevations reported to the Conservation and Survey Division of the University of Nebraska-Lincoln in cooperation with the U.S. Geological Survey and the Natural Resources Districts. It shows a large area in the north half of the Basin, including large parts of Adams, Clay, Fillmore, Nuckolls and Thayer counties, with a decline of up to 30 feet in ground water table elevations from predevelopment through the spring of 2005. This area is adjacent to a similar area of decline in the Big Blue River Basin. An additional area showing ground water table elevation declines includes part of southern Thayer County. There is a large area of ground water table elevation increases in central Kearney County. Figure LB-26 is the location map for selected ground water hydrographs across the Basin. Figures LB-27 through LB-32 are hydrographs (USGS 2005) which give a representative change in ground water table elevations for the particular area. Where possible a graph of a continuous recorder site is used.

Ground Water Management

The Basin primarily encompasses portions of two Natural Resources Districts (NRDs), the Little Blue NRD (LBNRD) and the Tri-Basin NRD (TBNRD).

The LBNRD and the TBNRD have each established a ground water management area (GWMA) for quality and quantity purposes. As part of the GWMA requirements in each of these NRDs, permits are required prior to the construction of wells pumping greater than 50 gallons per minute (gpm). The TBNRD, as part of the requirements in the quantity GWMA, has spacing restrictions more stringent than state statute for wells pumping in excess of 1,000 gpm, requires all new wells pumping greater than 50 gpm to install flow meters and report annual use, and requires TBNRD approval for transfers of ground water within or outside of the TBNRD. The TBNRD is currently in the process of certifying all irrigated acres within the TBNRD.

Surface Water

Hydrographs from five surface water gages in the Basin are included in this report, Figures LB-33 through LB-37. They are Big Sandy Creek at Alexandria, Little Blue River at Deweese, Little Blue River near Alexandria, Little Blue River near Fairbury, and Little Blue River at Hollenberg, Kansas, Figure LB-38. Streamflow in the Basin is primarily driven by precipitation and generally follows the annual variations in precipitation.

Surface Water Use

As of October 1, 2005, there are approximately 650 surface water appropriations in the Basin for a variety of uses. The majority of the surface water appropriations are for irrigation use and they tend to be located on the major streams. There are no instream flow appropriations in the Basin. The first surface water appropriations in the Basin were permitted in 1927 and development has continued through present day. The largest period of development occurred in the 1970’s, Figure LB-39 and Figure LB-40. The approximate locations of the surface water irrigated acres are shown in Figure LB-41. Information on specific appropriations is available in the Department’s biennial report. Information on categories of use can be found in Appendix H.

Surface Water Compact

The State of Nebraska is a signatory member of the Kansas – Nebraska Big Blue River Compact (Compact). The purposes of the Compact are: To promote interstate comity, to achieve an equitable apportionment of the waters of the Big Blue River Basin, to encourage continuation of the active pollution-abatement programs in each of the two states and to seek further reduction in pollution of the waters of the Big Blue River Basin.

The Compact sets state line flow targets from May 1 through September 30. The targets for the Little Blue River are shown in Table LB-4 and are measured at the Little Blue River gage at Hollenberg. If the targets are not met, the State of Nebraska is required to:

1. Limit surface water diversions by natural flow appropriators to their decreed appropriations,
2. Close natural flow appropriators with priority dates junior to November 1, 1968 in accordance with the doctrine of priority,
3. Ensure that no illegal surface water diversions are taking place, and
4. Regulate wells installed after November 1, 1968, within the alluvium and valley side terrace deposits downstream of Walnut Creek, unless it is determined by the Compact Administration that such regulation would not yield any measurable increase in flows at the state line gage.

At the present time the Compact Administration has found that the regulation of those wells will not yield measurable increases in flow at the state line. Administration for the Compact occurred in 1988, 1991, 2002 and 2004 on the Little Blue River in Nebraska.

Table LB-4. State line flow targets for the Little Blue River.

Month	Target Flow
May	45 cfs
June	45 cfs
July	75 cfs
August	80 cfs
September	60 cfs

Analyses for the Fully Appropriated Determination

Surface Water Administration

In the 78-year period since the first surface water appropriation was perfected in the Basin, there have only been a few recorded instances of surface water administration in the administrative record, with the first occurring in 1978. A summary of water administration that occurred between 1985 and 2004 can be found in Table LB-5. The junior surface water appropriations in the Basin on Rose Creek had an average of 57 days in which surface water was available for diversion from July 1 through August 31 and 144 days in which surface water was available for diversion from May 1 through September 30. The junior surface water appropriations in the rest of the Basin on average had 59 days in which surface water was available for diversion from July 1 through August 31 and 146 days in which surface water was available for diversion from May 1 through September 30.

Table LB-5. Water Administration in the Little Blue River Basin between 1985 and 2004.

Year	Water Body	Days	Closing Date	Opening Date
1988	Little Blue River	50	Aug 11	Sep 30
1989	Rose Creek	4		
1991	Little Blue River	45	Aug 16	Sep 30
1991	Rose Creek	94	Jun 28	Sep 30
2002	Little Blue River	11	Jul 18	Jul 29
2002	Little Blue River	13	Aug 6	Aug 19
2002	Little Blue River	7	Sep 9	Sep 16
2004	Little Blue River	10	Sep 13	Sep 23

The senior surface water appropriations that caused administration in the Basin have priority date years prior to 1985 (1968 is the known date from the administration record); therefore it is not necessary to reconstruct the water administration table.

Determination of Hydrologically Connected Area

The 10/50 area for the Basin was determined from the results of the MODFLOW ground water model developed by the Upper Big Blue NRD, Figure LB-42. This model was developed from the COHYST models developed for the Platte River and the surrounding area. Documentation on how the model was developed and used for this determination is in Appendix E.

Lag Impacts

a) Current Well Development

Even though a MODFLOW ground water model was available to determine the 10/50 area; it did not provide data on the lag impacts from ground water wells. In the western half of the Little Blue River Basin no sufficient transmissivity or specific yield data are available on a regional basis. Because of the lack of sufficient data, lag impacts from pumping ground water wells could not be determined using the Jenkins method at this time.

b) Future Well Development

The future well development lag impact calculation was not carried out for the same reasons as stated above. Estimates of the number of high capacity wells that would be completed over the next 25 years if no new legal constraints were imposed on the construction of such wells were calculated based on extrapolating the present day rate of increase in well development into the future, Figure LB-43. For the past 20 years, the rate of increase in high capacity wells is nearly linear at a rate of 103 wells per year.

Future Surface Water Development and Uses

The number of surface water appropriations in the Basin has grown steadily over the past 30 years and it appears reasonable to project that that trend will continue into the future, Figure LB-39. The number of acres permitted for surface water irrigation also has grown steadily for the past 30 years, Figure LB-40.

Ability to Satisfy Net Corn Crop Irrigation Requirement

Figure LB-44 shows the net corn crop irrigation requirement for the Basin. The map shows the net corn crop irrigation requirement to range from 10.0 inches in the northwest portion of the Basin to less than 7.0 inches at the southeast corner of the Basin. Assuming a surface water diversion rate equal to 1 cubic foot per second per 70 acres and a downtime value of 10 percent; depending on the location in the Basin, it takes between 18.6 and 26.6 days annually to divert 65% of the net corn crop irrigation requirement from July 1 through August 31 and 24.3 to 34.7 days to divert 85% of the net corn crop irrigation requirement from May 1 through September 30.

The surface water administration analysis showed an average of at least 57 days in which surface water was available for diversion from July 1 through August 31 and an average of at least 144 days in which surface water was available for diversion from May 1 through September 30.

Sufficiency of Surface Water Supply [Nebraska Revised Statutes Section 46-713(3)(a) (Reissue 2004)]

The average number of days in which surface water was available for diversion in both the July 1 through August 31 and the May 1 through September 30 time frames required by Department rule 457 Nebraska Administrative Code (NAC) 24.001.01 exceeds the number of days surface water is required to be available pursuant to the rule during those same periods. Because the average annual number of days in which surface water was available for diversion far exceed the number of days required (57 available versus 23.9 needed and 144 available versus 31.3 needed) it is unlikely that the existing level of well development will cause flows in the Little Blue River or its tributaries to fall to the point where they may become fully appropriated without the initiation of additional uses. Table LB-6 summarizes the results of comparisons between the number of days surface water must be available to meet the 65% and 85% net corn crop irrigation requirements and the number of days in which surface water was available for diversion to the junior surface water appropriations.

Table LB-6. Summary of Comparison Between Net Corn Crop Irrigation Requirement and Number of Days Surface Water is Available for Diversion.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Annual Number of Days Available to the Junior Surface Water Appropriations (1985-2004)	Average Annual Number of Days Available in 2030 with no Additional Well Development	Average Annual Number of Days Available in 2030 with Additional Well Development
July 1 – August 31	26.6	57 (30.4 days above the requirement)	Not Calculated*	Not Calculated*
May 1 – September 30	34.7	144 (109.3 days above the requirement)	Not Calculated*	Not Calculated*

* This number was not calculated. Because the number of days in which surface water was available for diversion far exceed the number of days necessary to meet the net corn crop irrigation requirement, the final conclusion would not change even with the addition of lag impacts from additional wells.

Sufficiency of Streamflow for Ground Water Supply [Nebraska Revised Statutes Section 46-713(3)(b) (Reissue 2004)]

Since the criteria for Nebraska Revised Statutes Section 46-713(3)(a) were satisfied, the conclusion for this section is the same for reasons explained in the report introduction.

Sufficiency of Surface Water Supply for Compliance with Compacts or State Laws [Nebraska Revised Statutes Section 46-713(3)(c) (Reissue 2004)]

As discussed previously, Section 46-713(3) requires the Department to make a determination that a basin is fully appropriated if current use of hydrologically connected surface water and ground water will create a reduction in the flow of a river sufficient to cause Nebraska to be out of compliance with an interstate compact. The requirements for compliance with the Kansas – Nebraska Big Blue River Compact are stated in the surface water compact section of this Basin chapter. As long as Nebraska administers surface and ground water in compliance with the Compact, decreased streamflow, in and of itself, will not cause Nebraska to be in noncompliance; therefore, any depletion would not cause Nebraska to be in noncompliance. However, decreased streamflows could increase the number of times the state would have to administer to remain in compliance.

The future usable water supply in the Basin may actually improve in the future if water can be made available to augment state line flows to meet Compact targets. A cooperative study between the Department, the U.S. Bureau of Reclamation, and the Basin NRDs is tentatively planned to examine the value of augmentation water and to develop potential criteria for locating reservoirs to store and release augmentation water.

Future Development of Surface and Ground Water [Nebraska Revised Statutes Section 42-713(1)(b) (Reissue 2004)]

Given the rate of registered ground water well and surface water appropriation development, the conclusion that the Basin is not fully appropriated would not change even if no additional legal constraints were placed on development and a reasonable projection of a continuation of the current trend of well development of the last 20 years is used.

Conclusions

There is no evidence that current ground water depletions to streamflow in the Basin are affecting surface water users sufficiently to meet the criteria for being fully appropriated as found in Department rule 457 NAC 24.001.01 when compared to the amount of surface water available at the present time.

There is not sufficient data available at this time to determine the lag impact over the next 25 years; however, due to the fact that the number of days in which surface water was available for diversion far exceeds the number of days required to meet the net corn crop irrigation requirements, it is unlikely that any lag impact could sufficiently affect the streamflow to lower the number of days in which surface water was available for diversion below the criteria for being fully appropriated as found in Department rule 457 NAC 24.001.01.

Based upon available information and its evaluation, the Department has reached a determination that the Basin is not fully appropriated. The Department has also determined that even if no additional legal constraints are imposed on future development of hydrologically connected surface water and ground water and reasonable projections are made about the extent and location of future development, this conclusion would not change.

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